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AUTHOR DePaoli, Marilyn M.; And Others
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ABSTRACT

Stanford University's use of a risk assessment methodology to improve the management of systems development projects is discussed. After examining the concepts of hazard, peril, and risk as they relate to the system development process, three ways to assess risk are covered: size, structure, and technology. The overall objective for Stanford University is identified: to convert a general understanding of risk factors into specific, quantifiable terms that can be compared over time and against other projects. Specific risk assessment questions are listed, along with criteria for questionnaire design. It is noted that the questionnaire is used at key points in a project's system development life cycle, as well as to update the portfolio risk profile at specific times during the year. Questionnaire responses indicate the extent of hazards and perils for each project using numeric values that are converted to percentiles and composite scores for each risk area. Graphs are included to show risk assessment for a new fund-raising system, an accounting maintenance program, and a portfolio assessment for a set of systems development projects. Attention is also directed to management decisions using risk analysis. (SW)

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MANAGING RISK IN SYSTEMS DEVELOPMENT

Marilyn M. DePaoli
Peat, Marwick, Mitchel & Co.

David J. Ernst
Stanford University

K. Scott Hughes
Peat, Marwick, Mitchell & Co.

Implementing major new information systems continues to be a risky venture. This paper presented at CAUSE 83, described a risk assessment methodology that has been developed to better manage the risks associated with systems development projects. The risk assessment methodology was described and illustrated by showing how Stanford University has used it to improve the management of its systems development efforts.

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MANAGING RISK IN SYSTEMS DEVELOPMENT

Implementing major, new administrative systems for colleges and universities continues to be a risky venture. Campus officials must address complex systems approaches and design decisions as they attempt to keep pace with technological advances in computing hardware, software and communications. It is no longer unusual for development of these systems projects to exceed \$1 million. Failures can jeopardize normal operations such as registration, payroll schedules and sponsored project billings. With unsuccessful projects, scarce financial resources are wasted, jobs can be lost and the credibility for future successes severely damaged.

Traditionally, we have not been very sophisticated in understanding what makes one kind of systems development project less likely to succeed than another. We know intuitively that projects of long duration normally have more problems than shorter term projects. Likewise, projects involving many end users, such as an integrated student information system, are generally more difficult and higher risk than projects involving only one or two users. Many other factors, such as familiarity with the technology, experience of the project management and the impact on user operations, suggest that there may be a variety of interrelated reasons contributing to a project failure.

If a way could be found to identify each of these risk factors and assess their importance for a particular project, we might be able to make management decisions that would change the inherent risk of our development projects and give us a better chance for success.

In the September-October 1981 Harvard Business Review, F. Warren McFarlan published an article, "Portfolio Approach to Information Systems," proposing that major disasters in system development efforts could be averted by assessing the risk of projects, separately and in the aggregate, in advance of implementation. He advocates that the management approach should be designed to fit the level of project and portfolio risk.

Professor McFarlan's article generated a great deal of interest among University management as it described systems development issues that continue to plague the University. Stanford requested Peat Marwick's assistance in expanding on McFarlan's basic concepts to develop a risk assessment process specifically tailored to the University environment.

After the analytic structure was completed in April 1982, Stanford piloted the method prior to institutionalizing the process. This article discusses the University's approach to risk assessment and portfolio* management.

UNDERSTANDING WHAT RISKS ARE

Risk analysis requires an understanding of the basic concepts of hazard, peril and risk as they relate to the system development process.

- A hazard is the specific situation that introduces or increases the probability of occurrence of a loss arising from a peril, or that may influence the extent of a loss. Such situations are slippery floors, inexperienced management or earth faults. In a system development process, hazards are defined as situations from which peril and loss might be anticipated, such as a large number of user departments, inexperience with large system development efforts, or insufficient user involvement in the project.
- A peril is the contingency which may cause a loss, such as an accident, explosion or fire. In a system development process, perils are such contingencies as poor system design, design not meeting user requirements and budget overruns.

*By a "portfolio" we mean the complete set of systems development projects.

- Risk is the uncertainty as to an event's happening or the extent of consequences if it does happen. For example, the San Andreas fault (hazard) can cause an earthquake (peril) with risk varying depending on such factors as population density and time of day of occurrence. Risk for a university's system development process involves exposure to adverse consequences such as the failure to meet user system requirements, costs that vastly exceed budgets, and completion schedules much longer than anticipated.

By measuring risk, we are not implying that no risks be taken. However, we need to understand risks fully to effectively manage them. Generally, higher risk system development projects must have associated higher benefits. The choice of the best route for development requires an evaluation of the risks involved as to their significance, acceptability, probability, consequences and potential benefits to be realized. Among the factors to be considered are:

- What are the alternatives?
- What are the associated risks of the alternatives?
- What is the risk of not developing a system?

Once the risks have been evaluated, we can take actions that change the level of risk or make the deliberate decision not to intervene.

HOW TO ASSESS RISK

Risk in system development efforts can be assessed from three key elements. These elements are size, structure and technology.

- Size includes such characteristics as the amount of development budget, length of time to develop, staffing levels and number of user departments involved.

- Structure considers the degree to which the users and data processing can define the requirements of the system, the impact on user operations and procedures, the functional and management qualifications of the data processing project team and the administrative and control procedures employed.
- Technology examines the technical experience of the project team, the technological approach, the development environment, and the technical requirements of the system.

Table I illustrates key factors identified for Stanford that reflect the size, structure and technology elements for that institution's systems development process.

The components used to assess risks will vary for each institution depending on the approach taken toward systems development. For example, institutions emphasizing the use of commercially available software and avoiding "home grown" systems will have risk components that are significantly different from those that do primarily in-house development. Institutions that have chosen to use only leading-edge or state-of-the-art technology will have much different risk components than institutions that elect to use proven or old technology.

At Stanford, we closely examined our approach to systems development projects and postulated 63 questions that tied back to the three elements: size, structure and technology. Table II illustrates some of the questions for Stanford.

An overall objective in Stanford's approach to risk assessment is to convert a general unquantified understanding of risk factors into specific, quantifiable terms that can be compared through a project's life cycle, between projects and across organizations. This overall objective led to a set of criteria to be used in determining specific questions and classifications. The criteria used in the questionnaire design are:

Table I

FACTORS THAT AFFECT RISK• SIZE

- Dollars
- Time
- Flexibility in schedule
- Data processing staffing level
- User staffing level
- Ease of staffing
- Number of user departments

• TECHNOLOGY

- Hardware
- Software
- Development tools/techniques
- Communications approach
- Use of software packages
- Technical experience of project team
- Availability of backup personnel
- Vendor experience
- Stability of development environment
- Data conversion complexity
- Performance requirements
- Security requirements
- Complexity of application interfaces

• STRUCTURE

- Project management
- User support, attitude and commitment
- User functional and data processing experience
- Project leader experience
- Project team functional knowledge
- Functional requirements definition and volatility
- Impact on user operations

Table 11

SAMPLE RISK ASSESSMENT QUESTIONS

I. SIZE

D. USER STAFFING LEVEL

1. What is the expected maximum size of the user project team?
 - a. 1 to 2
 - b. 3 to 5
 - c. 6 to 8
 - d. More than 8
2. Is the user staffing level (expected staffing level) adequate for the project?
 - a. Adequate level of staffing
 - b. Slightly understaffed, anticipate minor impact on project schedule
 - c. Severely understaffed, will lengthen project schedule
3. What percentage of the user project team can be staffed with existing personnel?
 - a. 90% to 100%
 - b. 67% to 89%
 - c. 34% to 66%
 - d. 0% to 33%
4. How difficult will it be to obtain additional permanent staff or contractors due to specialized skill requirements, budget constraints, etc.?
 - a. Not difficult
 - b. Somewhat difficult
 - c. Very difficult

E. NUMBER OF USER DEPARTMENTS

1. How many departments could be described as primary system users in this project?
 - a. One
 - b. Two
 - c. Three
 - d. Four or more

2. How many departments are involved as secondary users in this project (e.g., primarily for information purposes)?
 - a. None or one
 - b. Two
 - c. Three or more

II. STRUCTURE

C. DATA PROCESSING TEAM QUALIFICATIONS

1. What is the experience of the data processing project leader with projects of similar type?
 - a. Demonstrated performance at Stanford with similar systems
 - b. Demonstrated performance at Stanford but with different type systems
 - c. Prior experience with similar systems but no Stanford experience
 - d. No prior experience
2. What is the experience of the data processing project leader with projects of similar size?
 - a. Demonstrated performance at Stanford with similar systems
 - b. Demonstrated performance at Stanford but with different size systems
 - c. Prior experience with similar systems but no Stanford experience
 - d. No prior experience

III. TECHNOLOGY

C. DEVELOPMENT ENVIRONMENT

1. Will the project team have difficulty in obtaining adequate computer resources and development tools?
 - a. No problem anticipated
 - b. Limited problem
 - c. Serious problem
2. To what extent are changes in development hardware or software anticipated to impede progress on the project?
 - a. Limited impact
 - b. Moderate impact
 - c. Considerable impact

- Categories and subcategories represent major areas that influence risk of system development efforts, and a relative weight can be assigned to each classification. This implies that:

- questions should not attempt to address the totality of project attributes but only be indicators of risk for that classification; and
- the number of questions in a category or subcategory should be relatively proportional to the weight of that classification.

- Answers must be quantifiable and comparable across projects. This implies that:

- questions should be concise;
- no questions can be dependent on responses to other questions;
- only one answer per question is allowed;
- all questions must be answered; and
- answers, therefore, may be subjective, requiring informed judgment.

The questionnaire is used at key points in a project's system development life cycle, such as at initiation, definition of system development approach, and at major project milestones. In addition, it is used to update the portfolio risk profile at specific times during the year, such as prior to the budget cycle. It is intended to be completed by individuals knowledgeable about the project, such as the manager, project leader, analyst and the user. Naturally, responses will differ and will need to be reconciled.

Responses to the questions establish the extent of hazards and perils for each project. Numeric values are assigned to each response and are totaled within each subcategory. These values are converted to percentile values to

reflect the relative risk of the project for that subcategory. Each subcategory is weighted to determine percentile values to reflect the relative risk of the project by category and a composite score. Scores are classified as low, medium or high risk levels. Any project can be low in one area and high in another. Thus, overall risk is not a sufficient measure without also looking at the component scores.

ANALYZING THE RISKS

Responses to the questions can be presented in a graphic display that readily shows the relative risks for each project in the portfolio. The accompanying graphs illustrate how disparate risk can be in systems development projects. Figure 1 shows the risk assessment for a new fund-raising system. It is a large project (48 man-months) using a leading-edge technology (DBMS, networked, on-line updating) and has a relatively high risk level. On the other hand, Figure 2 shows a small accounting system project using well-known technology, and its risk level is much lower. In our analysis, we have determined that risk values of 40 and below are relatively low, 40 to 60 medium risk and above 60 relatively high risk.

A useful feature of the risk analysis is the communication that takes place among project team members. We found that perceptions of project risks frequently varied among the project manager, analysts, programmers and users. Often the difference in viewpoints was due to the lack of specific knowledge, such as the technology being used or the strength of the project team.

In the assessment of the accounting maintenance program (Figure 2), the user rated the project as medium risk, but the data processing manager, project leader and programmer all rated the same project as low risk. The difference in scores is dramatic. It is obvious that very little communication was taking place between the user and the data processing project team. While everyone was in general agreement as to the size of the project, they differed on the way the

project was structured and on the technical solution proposed. A meeting was obviously needed to discuss these differences. Unfortunately, that meeting never took place. The user did not get what he wanted, and some major reworking was required. Thus, the graphs were telling us something real, but because the project was quite small and because the graphs were not prepared until several months after the data was collected, the problem had long since been dealt with the hard way. In this case, it seems clear from the results that management could have stepped in early in the project life and ironed out the differences which existed.

Risk assessments for individual projects can be consolidated into a portfolio risk assessment for the entire set of systems development projects. Figure 3 is a representation of such a portfolio risk assessment. In this instance, it shows a balanced risk with a clustering at the 60 level which borders between a medium and high risk portfolio.

MANAGEMENT DECISIONS USING RISK ANALYSIS

Managing risk in systems development efforts is the primary objective of the risk assessment process. Management decisions occur at two levels, individual project management and portfolio management.

Project management is improved through the risk assessment process if the assessment is made at key points in the project's life cycle. These key points include:

- Prior to Initiation. An assessment of risk at this stage defines the risk level management is willing to assume. There should be a correlation between risk and benefit, i.e., the higher the risk the higher the benefits.
- Start of Project. At the start of the project, the budget has been defined, staff identified and most likely the technological approach is known.

FIGURE 1
PORTFOLIO RISK ASSESSMENT
FUND-RAISING SYSTEM

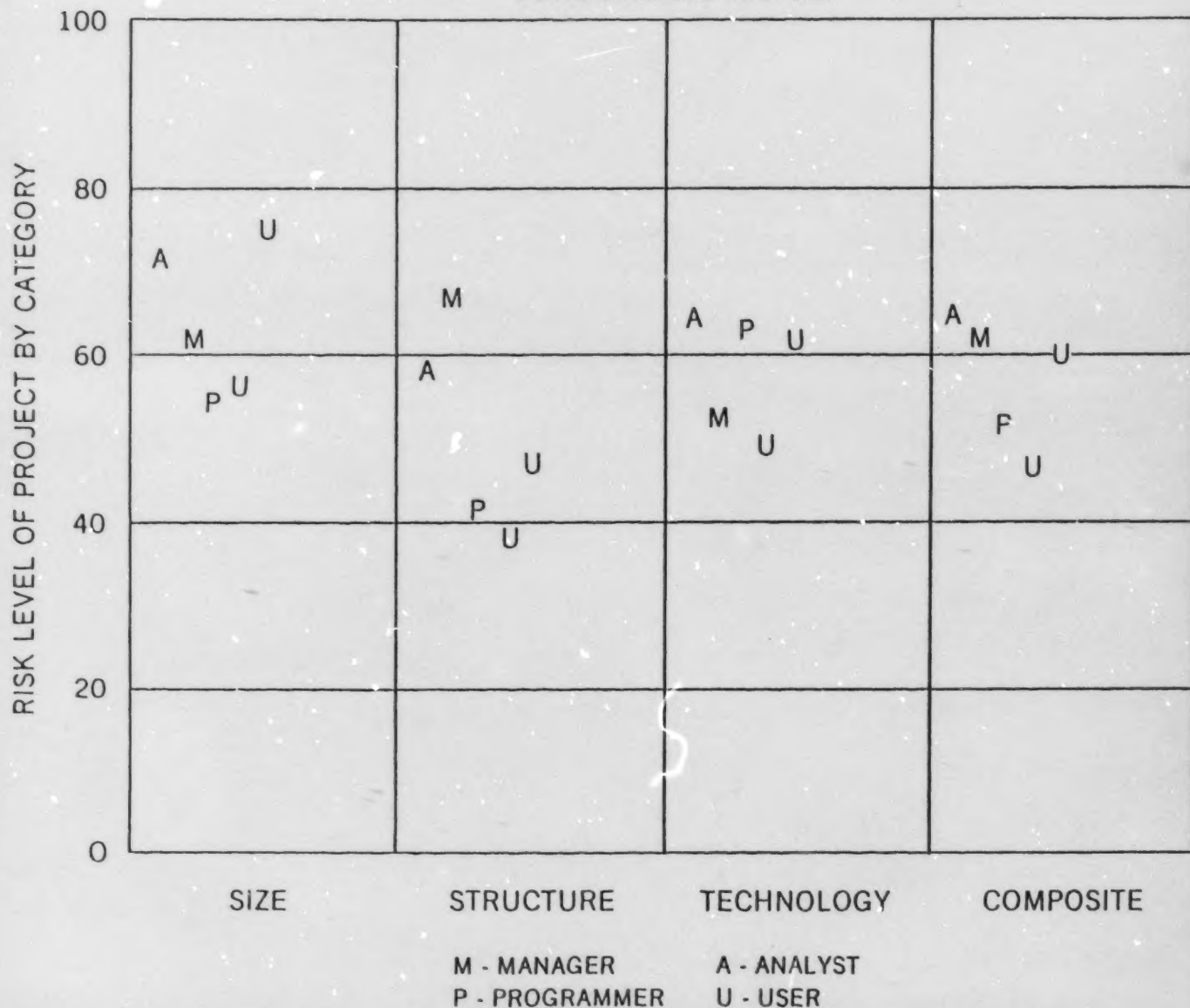


FIGURE 2
PORTFOLIO RISK ASSESSMENT
ACCOUNTING MAINTENANCE PROGRAM

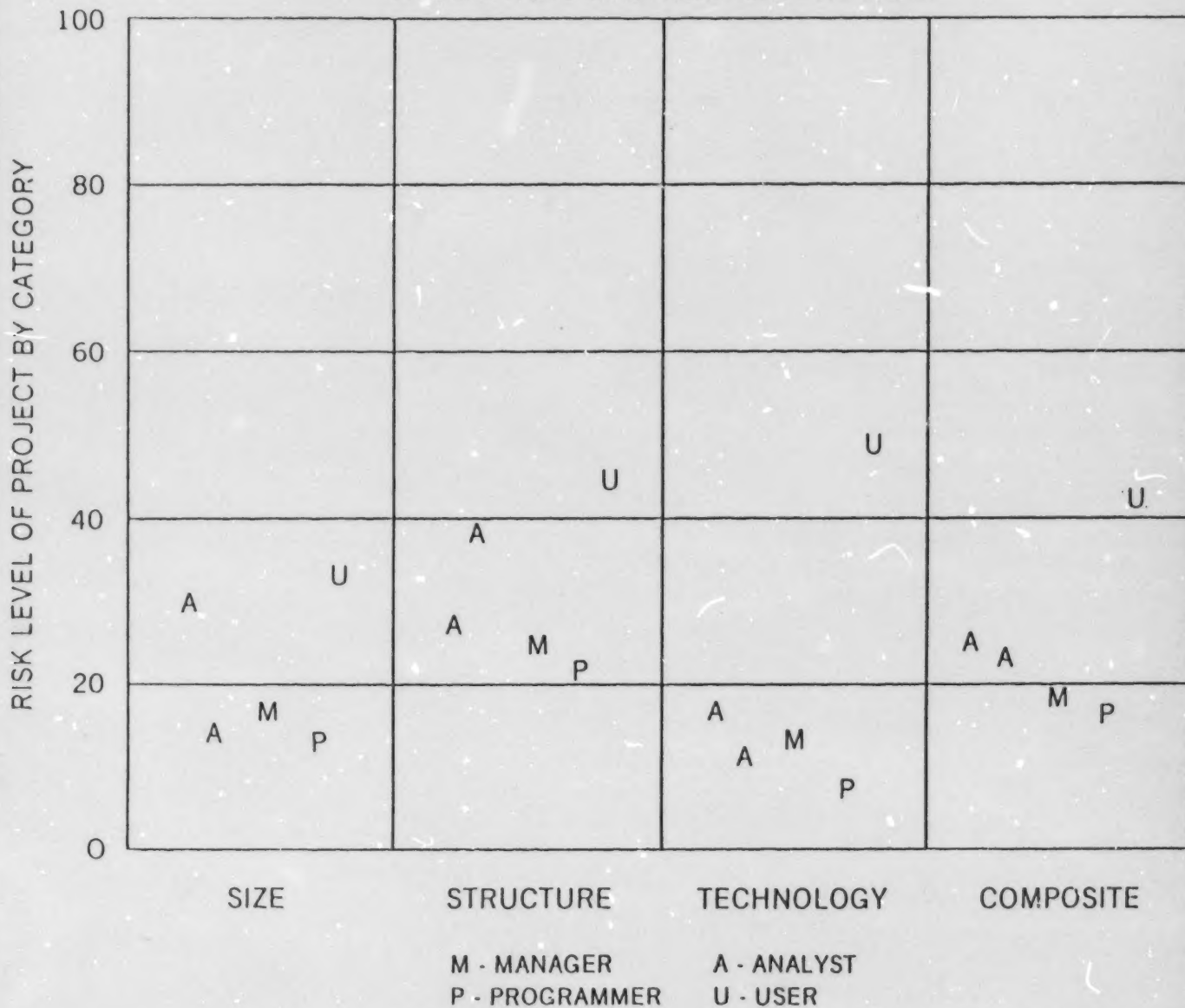
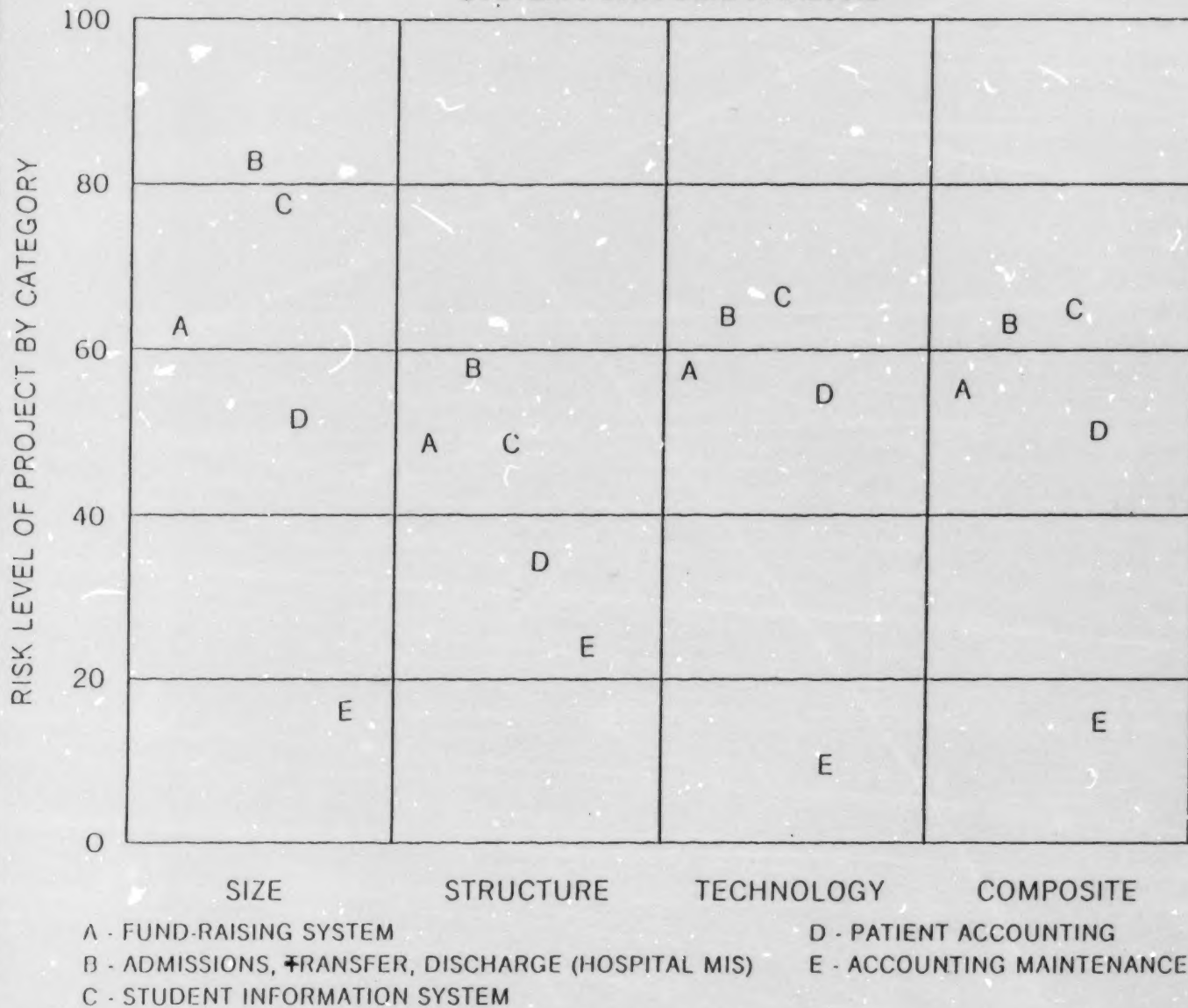


FIGURE 3
SYSTEM PORTFOLIO ANALYSIS



- Key Project Milestones. At each milestone, a risk assessment will reflect if the project continues to be well managed and under control. Delays in schedule, cost overruns and technology problems will be reflected in the assessment and increase the risk level.
- Completion of Project. A final risk assessment is necessary to complete the cycle and as part of the post-implementation review. Examination of the risk assessment trend for each completed project provides excellent comparisons for future system development efforts.

If a project's risk level varies from what we predetermine is appropriate, there are several actions that can be taken. Table III illustrates some of the actions that can be taken. Projects that have risks considered too high can be reconfigured and risks lowered. Likewise, projects that may have too low a risk level can be modified generally freeing up resources that can be used on higher risk projects.

Management of the portfolio can also be improved through the risk assessment process. An institution should predefine an acceptable risk level for its system development projects. The predefined risk level is dependent on the importance of data processing to that institution's academic mission, goals and program. For example, at Stanford it is important that administrative systems take best advantage of state-of-the-art technology and, when necessary to accomplish management objectives, use leading-edge technologies. Emphasis is placed on producing high quality management-oriented information necessary to support Stanford's aggressive and dynamic instruction and research program. Because of these information system and technology demands, Stanford is willing to accept a higher risk portfolio position than if it were not in such a complex and aggressive operating environment.

Table III

**MANAGEMENT OBJECTIVES MATRIX
DEPENDENT ON RISK LEVEL BY RISK ASSESSMENT CATEGORY**

RISK ASSESSMENT CATEGORY RISK LEVEL	SIZE	STRUCTURE	TECHNOLOGY
HIGH	• Break up project into sub-projects • Implement formal SDLC • Establish frequent project milestones • Establish formal project tracking & control system • Establish formal communication channels	• Increase user involvement • Implement formal SDLC • Redefine project objectives • Establish formal sign-off on user requirements • Increase training for users & data processing • Use more experienced staff or seek outside expertise	• Increase technical training for data processing • Hire in or contract for required technical skills • Examine package software alternatives • Use more familiar technology
↑↓	↑↓	↑↓	↑↓
LOW	• Use single phased approach • Implement simpler version of SDLC • Establish fewer milestones • Implement simpler version of project tracking & control system	• Opportunity to use less experienced management or staff on the project • Examine structure characteristics compared to other projects in portfolio	• Re-examine technological approach compared to other projects in portfolio • Opportunity to use staff with less technical expertise

With a predefined risk posture, an institution then has a benchmark to compare with the measured risk. Actual risk levels below the targeted level may indicate that expected benefits are not being programmed or that projects are overfunded, overstaffed or using outdated technologies. On the other hand, a risk level that exceeds the target may reflect overly ambitious goals, use of unfamiliar technologies or lack of staff and funding.

CONCLUSION

The risk assessment process adds a new and necessary ingredient to data processing management. As technologies advance and skilled professionals continue in short supply, we sit on the razor edge of success or failure in our system development efforts. With the ability to continually measure the level of risk of our development projects, we can better anticipate problems and make decisions that will forestall failures and create successes.